Developing winter wheat and winter pea for intercropping purposes

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Optimising the management itinerary

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SPW-DGO3

Context and Objectives





Why (re-)introducing pea in rotation ?

- Source of (plant-based) proteins
- Natural N supply / fertilisation
- Increase the biodiversity
- Increase the landscape diversity

Objectives

- Objectives of intercrop :
  - Decrease the inputs (N fertilisation, Pesticides, etc.)
  - Secure the protein production and the grain yield
  - Interesting contribution to farmers revenue ?
- Prerequisites :
  - Design and optimisation of the itinerary

History

Intercropping @ GxABT

- 2009-12 : Exploratory trials
- 2012-14
- 2014-16 } Project funded by DGO3 (Wallonia)
- 2016-18
- 2018-20 : PhD Thesis – Pierreux J.
- >2013 Collaboration with Wallagri to coaching farmers in this process.

Sustainable production of protein-rich seeds by optimization of the management itinerary of the winter pea - winter wheat association

Project design

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- Axis 1 : Vegetation structure and architecture
  - Sowing density
  - Choice of variety
- Axis 2 : Plant nutrition
  - Nodosity development
  - Plant development

Project design

- Axis 1 : Vegetation structure and architecture
  - Sowing density
  - Choice of variety
- Axis 2 : Plant nutrition
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- Axis 3 : Mechanical weeding (2017-18)
  - Comparison of itinerary and machines
- Axis 4 : Pesticide application (2017-18)
  - Fongicide
  - Herbicide

Sites description





Sites description

Soil :

- Cutanic Luvisol (WRB classification)
- Soil texture : silt 70-80 % - clay 18-22 % - sand 5-10 %
- “Classic” loamy soil of the Hesbaye Area

Climate :

- Temperate climate (Cfb in Köppen-Geiger classification)
- Rain : 819 [mm] per year
- Average temperature : 9.8 [°C]
- Average solar radiation : 825 [$J.cm^2.d^{-1}$]

Sites description

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Itinerary :

Year	Preceding crop	Sowing Date
2012-13	Winter Wheat & Sugar Beet	12 Nov.
2013-14	Sugar Beet	21 Nov.
2014-15	Sugar Beet	06 Nov.
2015-16	Sugar Beet	13 Nov.
2016-17	Sugar Beet	08 Nov.
2017-18	Sugar Beet	14 Nov.

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W. Wheat sowing : 15 Oct. - 15 Dec.

W. Pea sowing : 25 Oct. - 15 Nov.

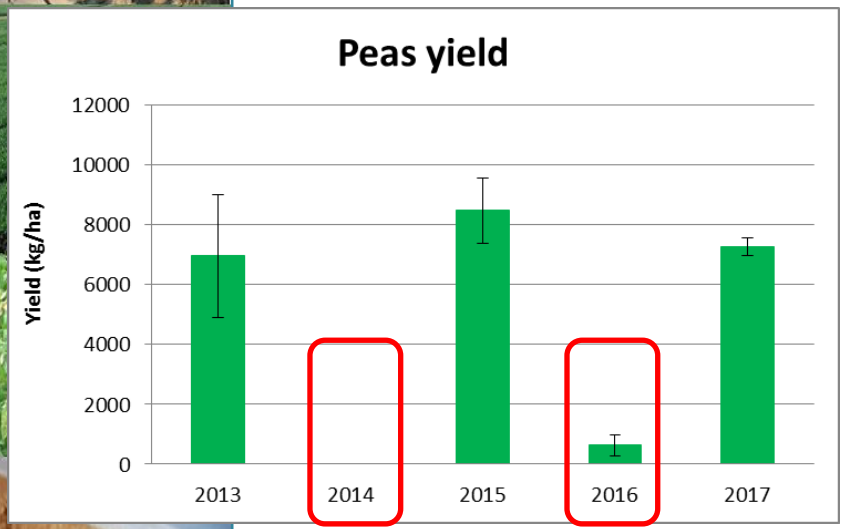
➔ Sowing window has to be between 25 Oct. and 15 Nov.

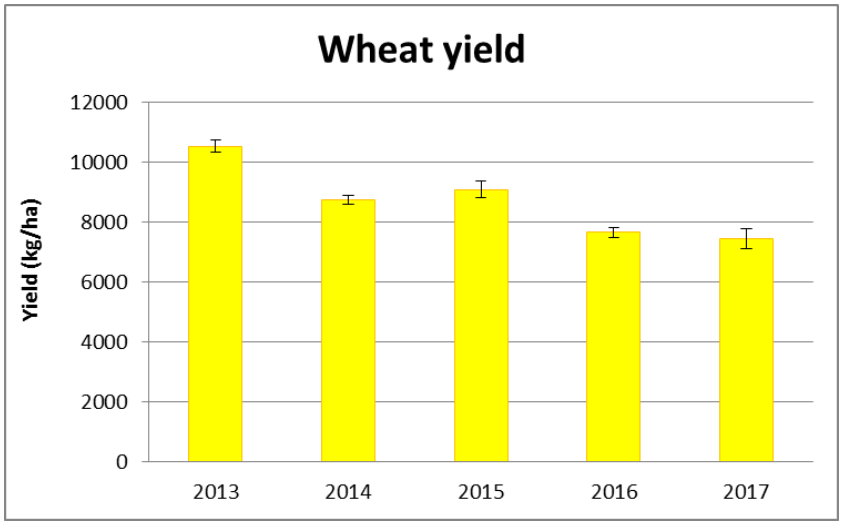
➔ Same sowing technique for both crop

Sites description ~ 1,000 plots per year

Example of results

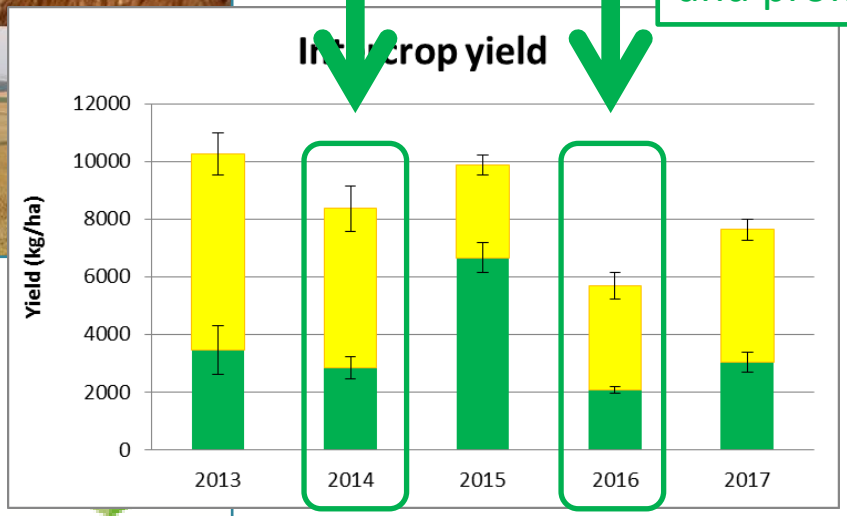
Results : Global performances

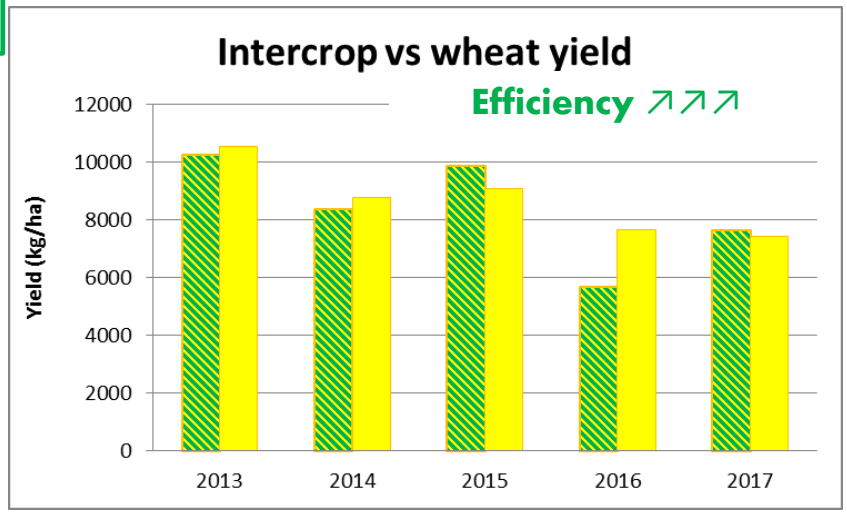




Lodging problem

Security of yield and profitability





Intercropping performances ≈ Wheat

Results : Global performances

Pea lodging (2016)

Intercrop (2016)

Results : Axis 1 – Varietal choice

$$LER = LER_{Pea} + LER_{wheat} = \frac{Mixed\ pea\ yield}{Pure\ pea\ yield} + \frac{Mixed\ wheat\ yield}{Pure\ wheat\ yield}$$

Land Equivalent Ratio récolte						
	2013	2014	2015	2016	2017	
Sy Epson Ivernel	1,43	0,66	1,28	4,12	1,23	Edgar Gangster
Sy Epson Spencer	0,85	0,52	1,17	3,42	1,15	Smart Furious
Edgar Ivernel	1,15	0,75	1,17	3,64		
Edgar Spencer	1,04	0,71	1,18	3,42		
Moyenne	1,12	0,66	1,20	3,65	1,19	

Bedoussac and Justes, 2010. Plant Soil 330, 37-54

Results : Axis 1 – Sowing densities

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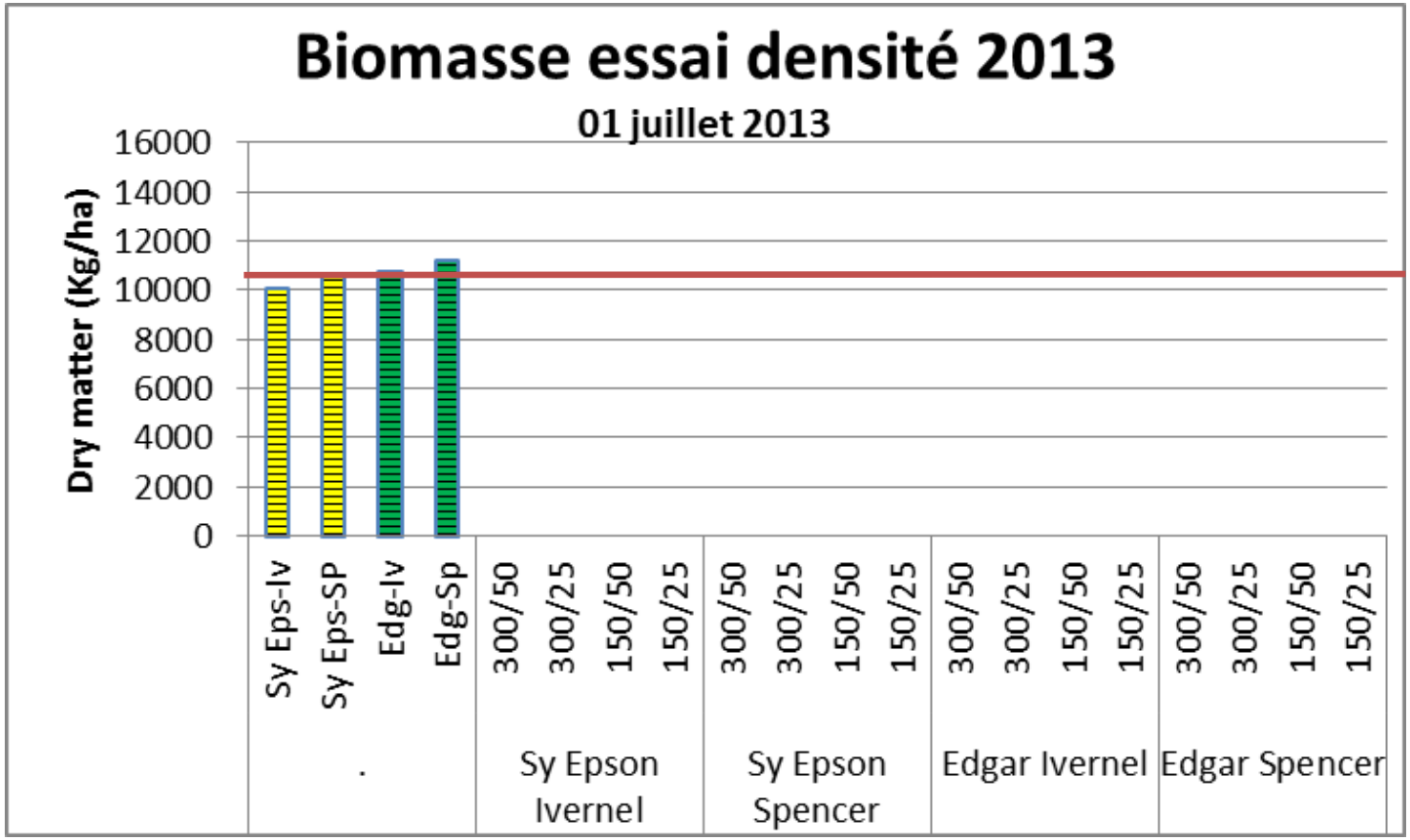
Impact of sowing densities on lodging (15/07/2016)

Densités (FH/Pois) /Association	Pur		300/50	300/25	150/50	150/25
	Pois	Froment	←			→
Sy Epson Gangster	100	0	9	0	12	1
Sy Epson Spencer	100	0	20	0	51	8
Edgar Gangster	100	0	6	0	0	2
Edgar Spencer	100	0	17	1	41	10

Results : Axis 1 – Varieties and densities



Biomass *monocrop* equivalent :

$$\frac{\text{Biom. pea/ha} + \text{Biom. wheat/ha}}{2}$$

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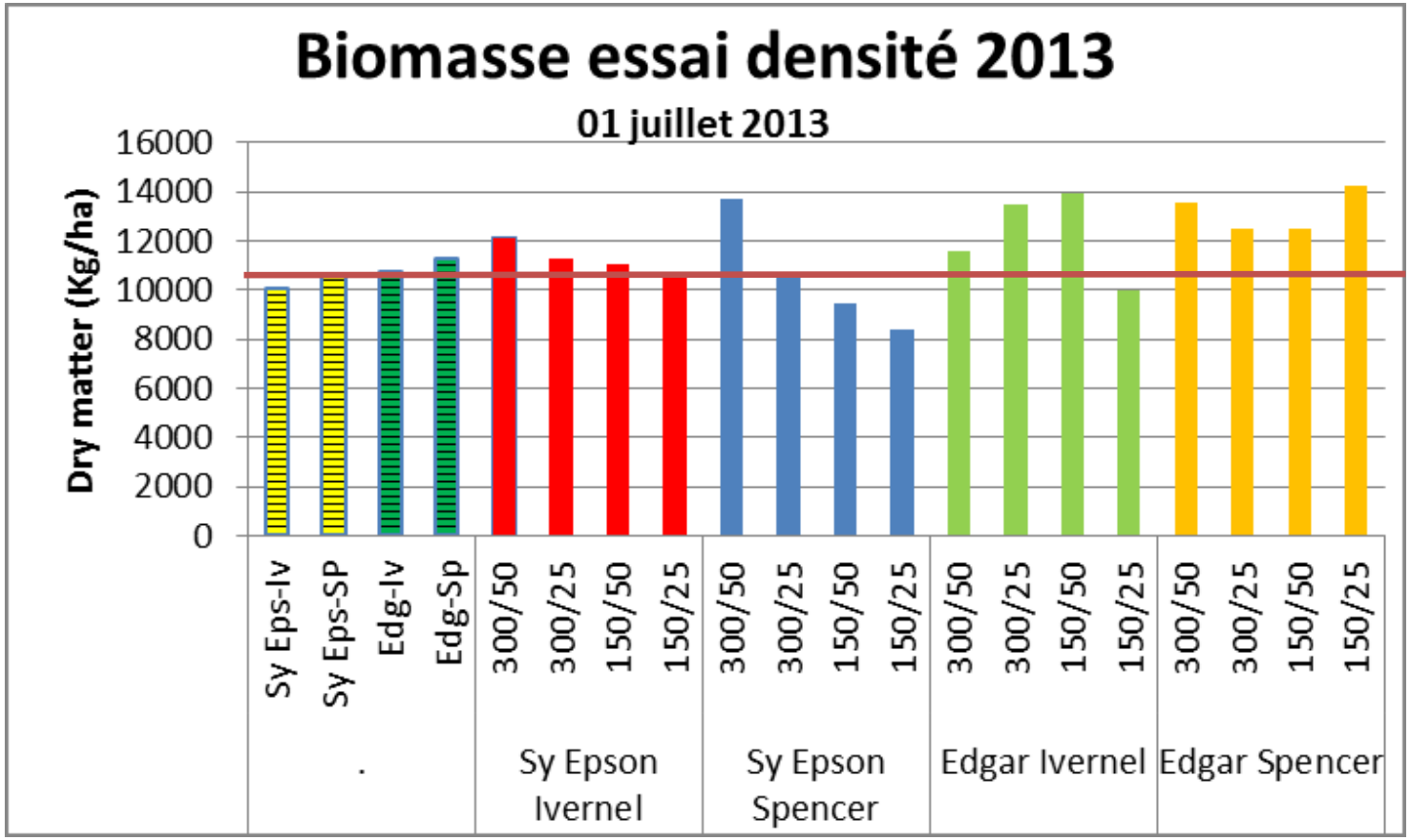

Biomass *monocrop* equivalent :

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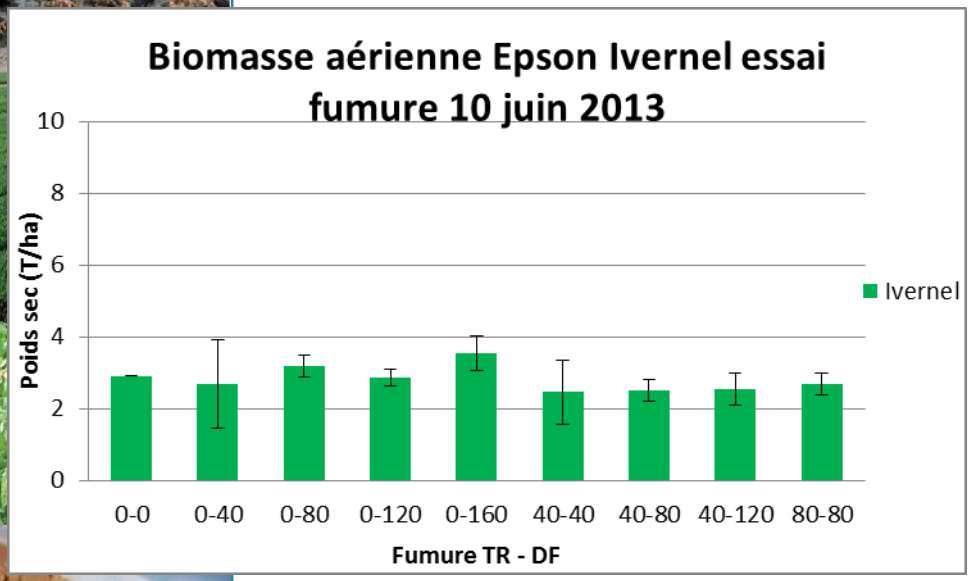
Observed intercrop biomass

Results : Axis 2 – Biomass production



➔ N fertilisation amount and timing does never seem to impact the biomass of pea

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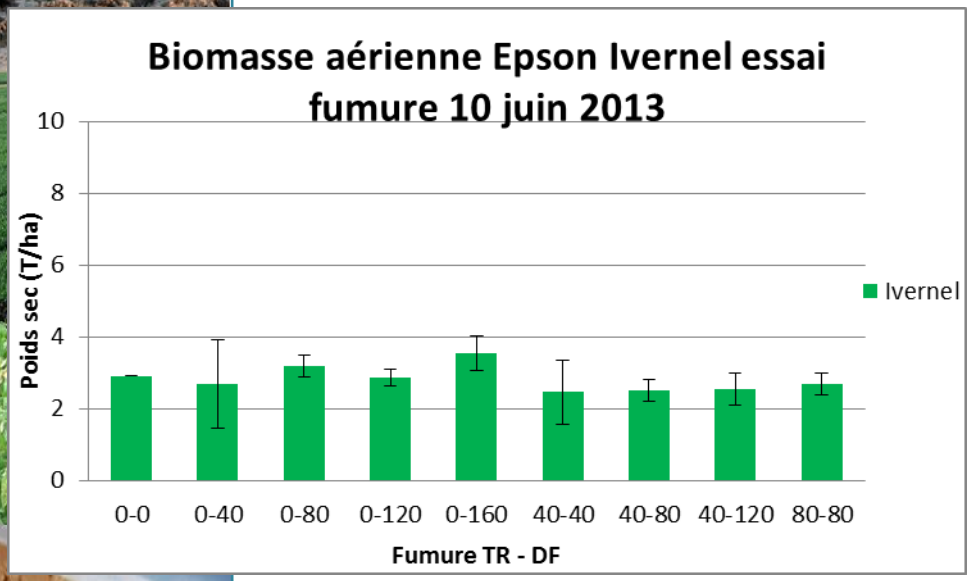

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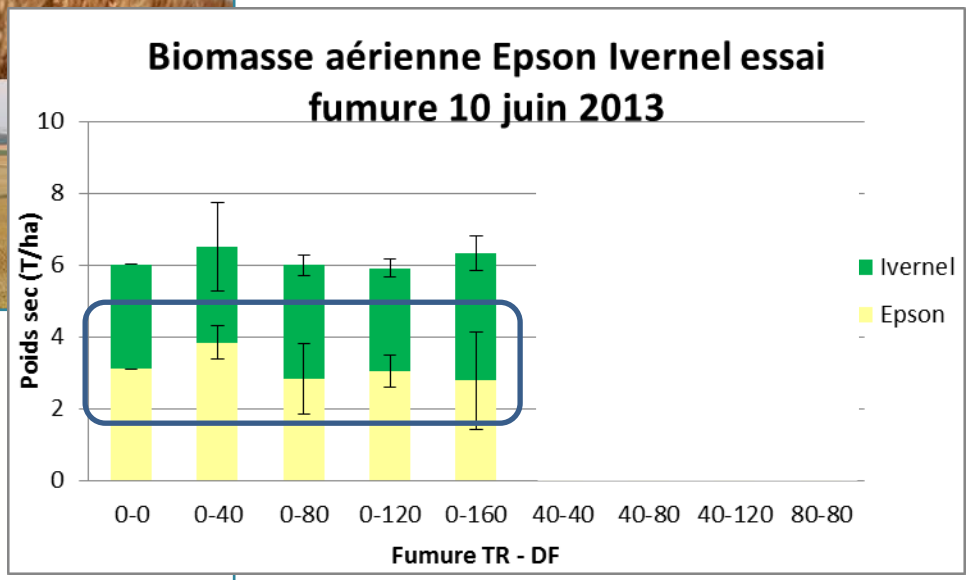
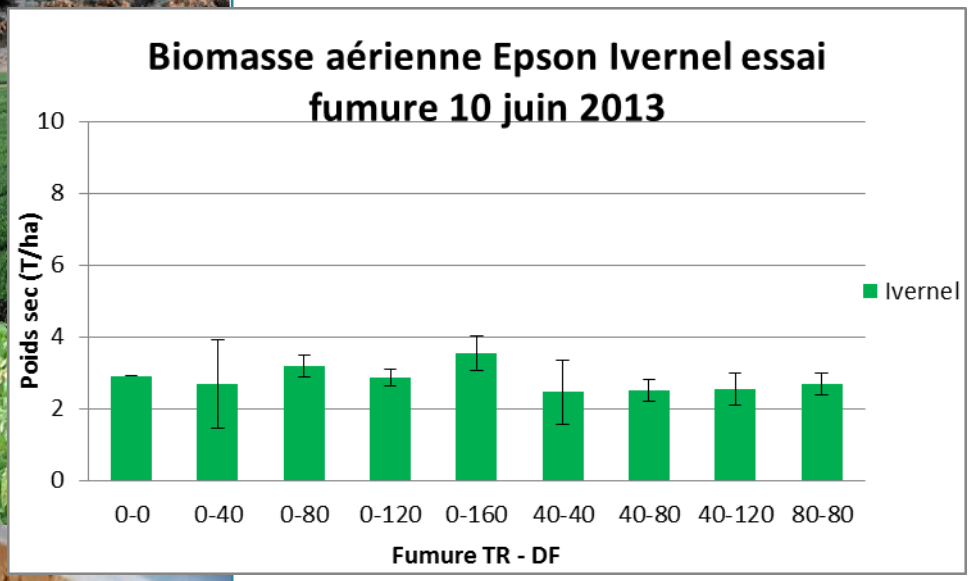


N fertilisation **@ ZS39:**

➔ Does not impact pea or wheat biomass

➔ Impacts wheat protein

Results : Axis 2 – Biomass production



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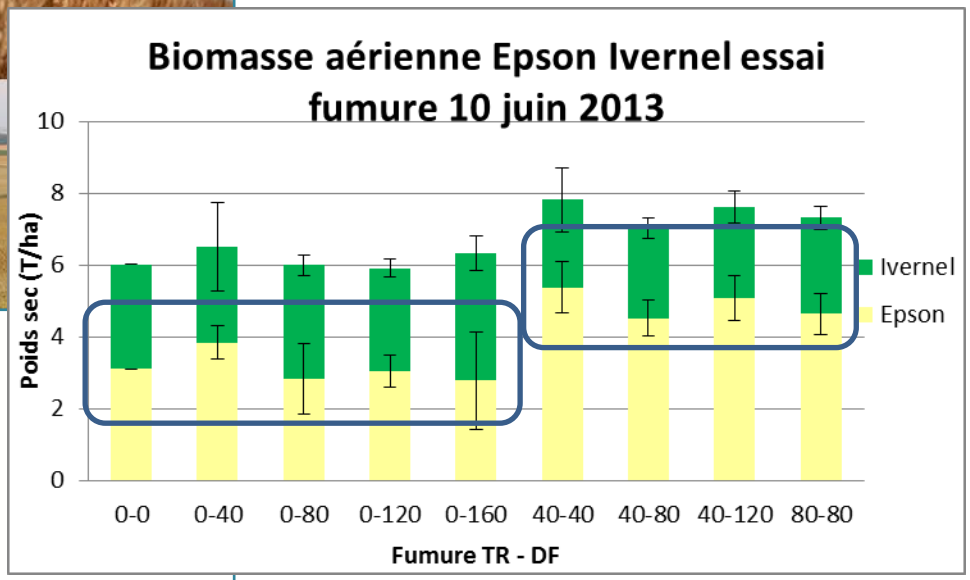

N fertilisation **@ ZS39:**

➔ Does not impact pea or wheat biomass

➔ Impacts wheat protein

N fertilisation **@ ZS29-30 :**

➔ Impacts wheat biomass and yield

Results : Axis 2 – Nodule production

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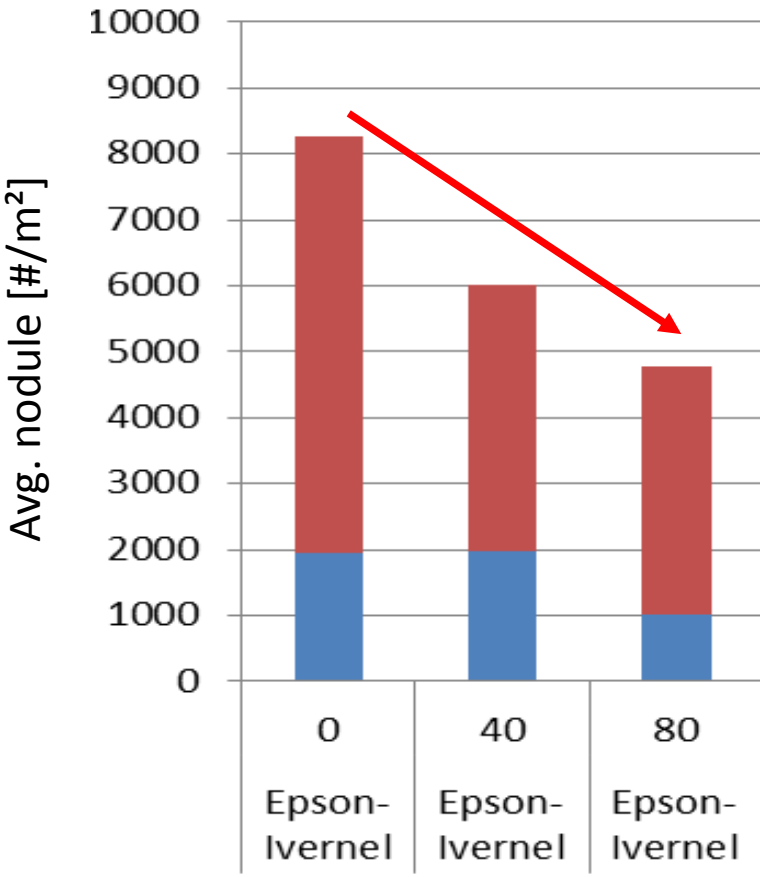
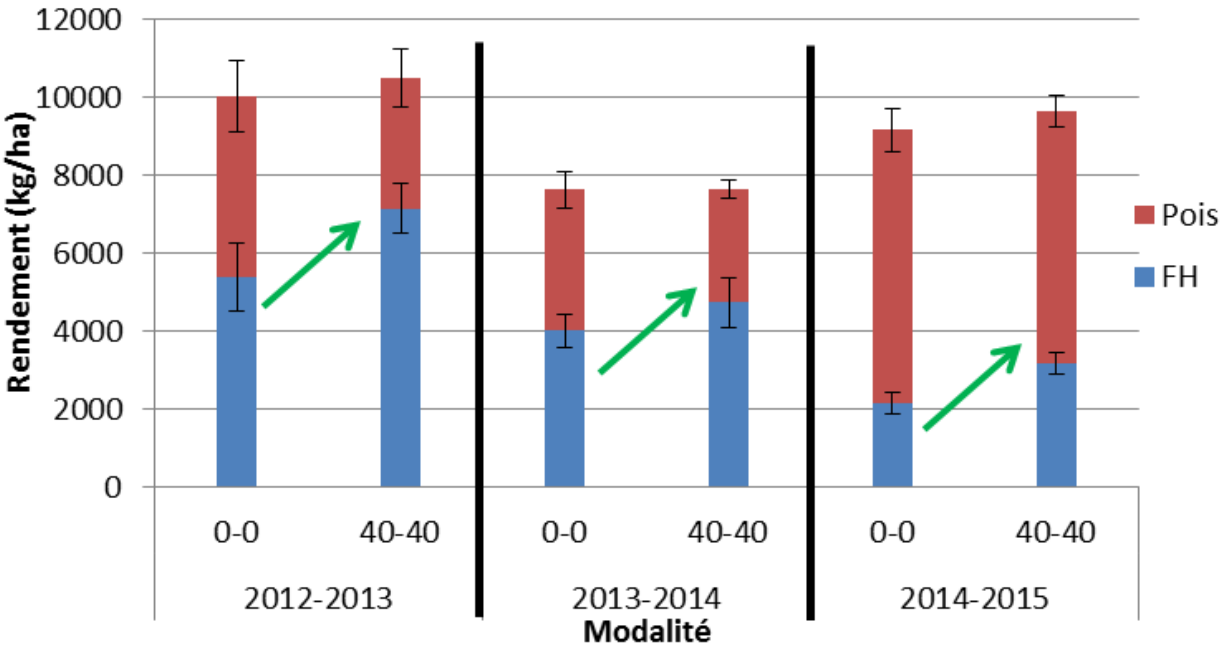


- On main root
- On secondary roots

➔ N fertilisation decreases the number of nodules

Results : Axis 2 – Yield



➔ Without N application, yields are fairly good

➔ N fertilisation increases intercrop production (especially wheat production)

➔ Not necessary to fertilize with too high level

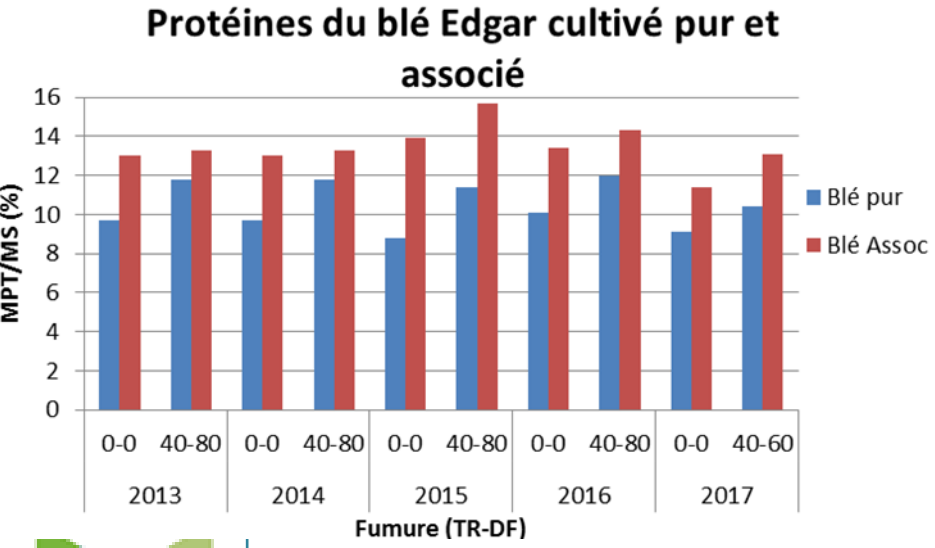
➔ N fertilization allow to play on the ratio wheat-pea (Interspecific dominance)

Results : Axis 2 – Protein production

W. Wheat – W. Pea intercropping allows

➔ to increase protein production within wheat grains

➔ does not impact proitein production of pea



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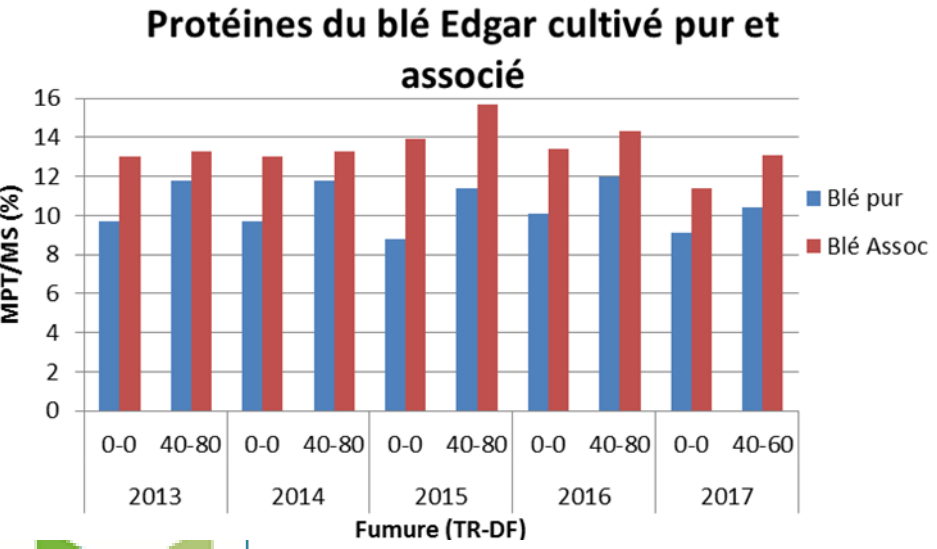
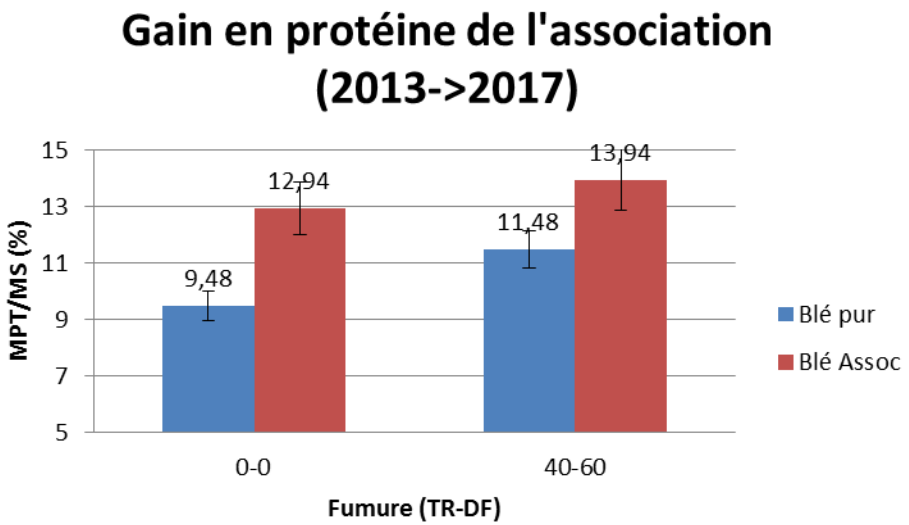
On average : + 3,46 % MPT/MS – 0kgN/ha

+ 2,46 % MPT/MS – 40-60kgN/ha





Conclusion

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Conclusions

- The management of w. wheat- w. pea intercropping is primarily a matter of ***art***

- To success with the association, one has to do the good choices :
  - Varieties to be in the association
    - ➔ Alone but above all in **association** (not always same behavior)
    - ➔ **Synchronicity** of the species and the varieties
  - The density of sowing
    - ➔ *Equilibrium* of **plant population**
    - ➔ Minimize the adverse effects of monocrop
  - The fertilization and the nutrition of plant
    - ➔ To optimize quantity and **quality**
    - ➔ Regulate the **interspecific competition**
  - …

Thanks for your attention

??? Questions ???

Ir. Pierreux Jérôme

Dr. Benjamin Dumont